

CIBO Estimated Capital Costs For Air Pollution Control Equipment For Biomass-Fired Industrial Boilers and Process Heatersⁱ

Pollutant	<u>Particulate Matter (PM)</u>	<u>Hydrogen Chloride (HCl)</u>	<u>Carbon Monoxide (CO)</u>	<u>Dioxin/Mercury (Hg)</u>
Likely Additional Control Required	Fabric Filter (FF)	Scrubber (e.g., spray dryer or wet scrubber)	Catalytic Oxidation (CATOX) or other combustion improvement projects	Carbon Injection (CI)
# of Biomass-Fired Boilers and Process Heaters	370 of the 434 biomass-fired units will need a new FF or an upgrade to their current FF or electrostatic precipitator (ESP).	358 of the 434 biomass-fired units need scrubbers or upgrades	73 of the 434 biomass-fired units need CATOX or combustion improvements	370 of the 434 biomass-fired units need CI (cost of required PM control device included in PM column as necessary)
Comments/ Assumptions	<ul style="list-style-type: none"> • If a unit did not already have a FF or ESP and there was information in the EPA database that indicated the unit cannot meet the proposed limit or there was no emissions information, we assumed a new FF. • If the unit already had a FF or ESP and there was information in the EPA database that indicated the unit cannot meet the proposed limit we assumed an upgrade to the existing FF or ESP. • FF base capital cost \$7 MMⁱⁱ; FF/ESP base upgrade capital cost \$4 MM.ⁱⁱⁱ 	<ul style="list-style-type: none"> • If there was information in the EPA database that indicated the unit cannot meet the proposed limit or if there was no emissions information in the EPA database, we assumed either a scrubber upgrade or new scrubber depending on whether the unit currently had a scrubber. • Scrubber base capital cost \$8 million; scrubber base upgrade capital cost \$4 million.ⁱⁱ 	<ul style="list-style-type: none"> • If there was information in the EPA database that indicated the unit cannot meet the proposed limit or if there was no emissions information in the EPA database and the boiler is not a fluidized bed unit or a unit with a high CO limit, then we assumed that capital would be necessary to either perform combustion/fuel feed improvements or other boiler improvement projects to reduce CO or install a CO catalyst. • A fixed cost of \$2 million was assumed for CO controls (either projects to improve combustion or fuel feed or installation of a CO catalyst). • NOTE: It is uncertain whether a CO catalyst can be applied effectively and efficiently to biomass-fired industrial boilers. 	<ul style="list-style-type: none"> • If there was information in the EPA database that indicated the unit cannot meet the proposed limit or if there was no emissions information in the EPA database, we added carbon injection. • A fixed cost of \$1 million was assumed for installation of a carbon adsorption system for Hg and/or dioxin control, as these systems do not vary much in cost by boiler size.
Total Capital Cost to Biomass-Fired Units: \$3.85 billion	\$1.6 billion	\$1.7 billion	\$146 million	\$370 million

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Capital Cost Per Unit	<ul style="list-style-type: none"> • Range of Costs Per Unit: \$769k to 21.3MM • Average Per Unit Cost: \$4.3MM^{iv} 	<ul style="list-style-type: none"> • Range of Costs Per Unit: \$1.2 to 22.5MM • Average Per Unit Cost: \$4.9MM 	<ul style="list-style-type: none"> • \$1 million per unit 	<ul style="list-style-type: none"> • \$2 million per unit

ⁱ The chart includes data for 434 biomass-fired units >10 MMBtu/hr. The 434 units are derived from 408 units in the biomass MACT subcategory in EPA's Boiler MACT survey database available here: <http://www.epa.gov/ttn/atw/boiler/boilerpg.html#TECH> and 26 units in the forest products industry that are biomass fired boilers at major sources but were not in EPA's database. Capital cost estimates are not intended to represent a worst case analysis. Rather, they represent typical retrofit costs for the various scenarios based on published reports, industry information on specific project costs, EPA reports or control device fact sheets, or actual BACT or BART analyses submitted to permitting agencies. A primary resource was the document "Evaluation of Air Pollution Control Costs for the Pulp and Paper Industry," prepared by National Economic Research Associates (NERA) in May 2003.

ⁱⁱ MM stands for million

ⁱⁱⁱ The base cost assumes a size of 250 MMBtu/hr, the boiler specific cost was calculated using a 0.6 power function and the actual boiler size in MMBtu (e.g., for a 100 MMBtu/hr boiler or process heater, the cost is the base cost times $(100/250)^{0.6}$).

^{iv} Average cost was calculated by adding up the per unit cost for every unit requiring controls to get the total cost for all units and then dividing the total cost by the number of units requiring controls.